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GUIDING ELEMENTS FOR A WEB-PROCESSING MACHINE

CROSS-REFERENCE TO RELATED APPLICATIONS

[001] This patent application is the U.S. national phase, under 35 USC 371, of PCT/DE2003/003474, filed October 20, 2004; published as WO 2004/037696 A2 and A3 on May 6, 2004; and claiming priority to DE 102 48 820.7, filed October 19, 2002; to DE 103 07 089.3, filed February 19, 2003; to DE 103 22 651.6, filed May 20, 2003 and to DE 103 31 469.5, filed July 11, 2003, the disclosures of which are expressly incorporated herein by reference.

FIELD OF THE INVENTION

[002] The present invention is directed to guide elements, and in particular is directed to turning bars, of a web-producing or web-processing machine. The guide element has a plurality of openings on its surface which are adapted for the discharge of a fluid under pressure. The guide element can be placed in at least two angular positions with respect to an incoming web.

BACKGROUND OF THE INVENTION

[003] A web guide element, configured as a turning bar, is known from DE 93 20 281 U1, and which can be brought into at least two angled position in relation to an incoming web. In the course of pivoting the turning bar from a first position into the other position, openings of an inner body are displaced withrespect to openings in an outer body of the turning bar, in such a way that the air outlet openings which are not needed are closed.

[004] A turning bar is disclosed in one embodiment of USP 3,744,693, in which a tube wall segment, which is made of a porous, air-permeable material, together with a base body, constitutes a closed pressure chamber. The porous segment constitutes a wall of the chamber and is embodied to be load- bearing over the width thereof and without a load-bearing support. In a second example, a segment with penetration bores is arranged in place of the porous segment.

[005] USP 5,423,468 shows a guide element which has an inner, load bearing base body with bores and an outer body of a porous, air-permeable material having pores of approximately 25 µm. The bores in the inner body are only

provided in the area which is expected to be looped or encircled by the web to be guided.

[006] JP 06 198836 discloses a turning bar, which is embodied, over its entire wall surface, from a porous sinter metal with opening of 10 to 30 μm through which a fluid can flow.

[007] Devices for guiding of a web are disclosed in WO 00/39011. A wall between a supply chamber for pressure fluid and the guide face is made to be solid and self-supporting from a porous material with mean pore diameters of less than 500 μm.

[008] DE 31 31 621 A1 shows a turning bar with two longitudinally extending chambers of half-shell configuration. These selectively work together with the web as a function of the position of the turning bar, in respect to the latter.

[009] A turning bar with openings in a longitudinal section that is arranged substantially around the entire circumference for the emergence of compressed air, and which can be brought into at least two angular positions in relation to an incoming web, is disclosed in DE 101 15 916 A1. The openings are assigned to

two substantially half-shell-like halves of the cylindrical surface area of the guide element.

[010] DE 31 27 872 A1 shows a pivotable turning bar, on whose one shiftable end blown air is supplied to the turning bar via a telescopic tube and an opening.

[011] EP 0 705 785 A2 deals with the transport and directional change of a web-shaped material, in particular in the form of a film material. Air outlet openings, which are embodied as open micro-pores or micro-bores, are only provided in the respective looped-around areas.

SUMMARY OF THE INVENTION

[012] The object of the present invention is directed to producing guide elements which are flexible in connection with the change of direction of a web and which are simple to produce.

[013] In accordance with the present invention, this object is attained by the provision of a guide element of a web-producing or of a web-processing machine with a plurality of openings adapted for the passage of fluid under pressure. These

openings are situated on the surface of the guide element. The guide element can be brought into at least two angular positions with respect to an incoming web. The openings are embodied as micro-openings with a diameter of less than 500 μm.

[014] The advantages to be gained by the present invention consist, in particular, in that a guide element, which can be flexibly inclined with respect to the web, is formed without a large structural outlay. The guide element is distinguished by an air cushion having a large degree of homogeneity with simultaneously small losses.

[015] By the use of conventional openings, forces can be applied point-by-point to the material, in the manner of an impulse of the jet, by the use of which, the latter can be kept away from the respective component, or can be placed against another component. Because of the distribution of micro-openings, with a high hole density, a broad support and, as a matter of priority, the effect of a formed air cushion, is applied. The cross section of bores previously used lay, for example, in the range between 1 and 3 mm. The cross section of the micro-openings of the

present invention is smaller by at least the power of ten. Because of this, substantially different effects arise. For example, the distance between the surface with the openings and the web can be reduced, the flow volume of fluid flow can drop considerably and because of this, flow losses, which possibly occur outside of the areas which act together with the web, can be clearly reduced.

[016] In contrast to generally known components with conventional openings, or bores, a greatly more homogeneous surface is formed with the formation of micro-openings on the surface with opening cross sections in the millimeter range and with a hole distance of several millimeters. In this context, micro-openings are understood to be openings in the surface of the component which have a diameter of less than or equal to 500 μm, and which advantageously are less than or equal to 300 μm, and in particular are less than or equal to 150 μm. A "hole density" of the surface provided with these micro-openings is at least one micro- opening per 5 mm^2, which equals to a hole density of 0.20/mm^2, and advantageously is at least one micro-opening per 3.6 mm^2, which equals to a hole density of 0.28/mm^2.

[017] The air cushion is homogenized by configuring the openings as micro-

openings. The volume flow exiting, per unit of area, can be reduced in such a way that a flow loss can be negligibly small even in the areas around which the web does not loop.

[018] The micro-openings can advantageously be configured as open pores terminating at the surface of a porous, and in particular, as the surface of a micro-porous, air-permeable material, or as openings of penetrating bores of small diameter, which extend through the wall of a supply chamber toward the exterior. Although the preferred embodiments to be described subsequently primarily show the guide element in an embodiment with a porous material, the embodiment of the guide element with penetrating bores is to be applied in the same way to the principle of pivotable turning bars represented there.

[019] In order to achieve a uniform distribution of air exiting from the surface, in the case of employing micro- porous material, and without at the same time large requiring layer thicknesses of the material with high flow resistance, it is useful for the component to have a rigid air-permeable support, to which support the micro-porous material has been applied as a layer. Such a support can be charged with

compressed air, which flows out of the support through the micro-porous layer and in this way forms an air cushion on the surface of the component.

[020] The support itself can be porous and will have a better air permeability than the overlying micro-porous material. It can also be formed of a flat material or of a shaped material which encloses a hollow space and which is provided with air outlet openings. Combinations of these alternatives can also be considered.

[021] To achieve a uniform air distribution, it is moreover desirable that the thickness of the layer correspond at least to the distance between adjoining openings.

[022] In the use of micro-bores, an embodiment of the present invention is advantageous, in which the side of the guide element, which faces the web and which has the micro-openings, is embodied as an insert or as several inserts in a support. In a further development, each insert can be releasably or, if desired, can be exchangeably connected with the support. In this configuration, cleaning and/or an exchange of inserts with different micro- perforations for adaptation of the guide elements to different materials, to different web tensions, to different

numbers of layers in the strand and/or partial web widths is possible.

BRIEF DESCRIPTION OF THE DRAWINGS

[023] Preferred embodiments of the present invention are represented in the drawings and will be described in greater detail in what follows.

[024] Shown are in:

Fig. 1a, a schematic representation of the turning bar in accordance with the present invention in a first position, in

Fig. 1b, a schematic representation of the turning bar in a second position, in

Fig. 2, a perspective view, partially in cross-section through the turning bar with a support and with a coating with porous material around the entire circumference of the turning bar, in

Fig. 3, a perspective view of the turning bar in accordance with the present invention and with micro-bores arranged over its entire circumference, in

Fig. 4, a schematic representation of a pivotable turning bar in a different

embodiment, and in

Fig. 5, a cross-section through a turning bar in accordance with Fig. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[025] A guide element 01, such as, for example, a web guide element 01, is used in a web-producing or a web-processing machine, such as, for example a paper-making machine, a winding machine, a packaging machine, or, in particular, in a printing press, for guiding, or for effecting a change in direction of a web 02, such as, for example, web 02 of material, or web 02 of material to be imprinted, which runs over the guide element 01. In particular, the guide element 01 is embodied as a turning bar 01, by the use of which, depending on its position relative to the direction of travel of the incoming or running-up web 02, a change in direction, by approximately +90° by or approximately -90°, is provided for the web 02 by having the web 02 looped around the turning bar 01. A pair of two parallel turning bars 01, each inclined by 45° with respect to the web transport direction, can be used for effecting a lateral offset. For tipping the web 01, as a pair of turning bars 01,

which cross each other and which are inclined by 45° or -45°, respectively in respect to the web transport direction can be provided. Several pairs of turning bars are advantageously arranged in a path of travel of a web 02.

[026] The turning bar 01, or the pair of turning bars, can be arranged downstream of a printing group and upstream of a folding apparatus, or can be located downstream of a dryer and upstream of a folding apparatus, of a rotary printing press. In a typical configuration, the turning bar 01 has an exterior diameter of from 60 to 100 mm, for example, and has a length of more than 1,200 mm, for example. In this case, the turning bar 01 has, or each of the two turning bars 01 has at least two positions and each turning bar 01 is, or are pivotable over 90° in particular, wherein, in a first position, a web 02 is looped around a first half of the surface area, as seen in Fig. 1a, and a second half of the surface area is being looped in a second position of the turning bar 01, as seen in Fig. 1b.

[027] As shown in Fig. 2, a surface area of the turning bar 01 has openings 03, such as, for example, micro-openings 03, through which a fluid, such as, for example, a liquid, a gas or a mixture thereof, and in particular air, which is under

higher pressure than the surroundings, flows. This fluid flows radially outwardly from hollow space 04, such as, for example, a chamber 04, and in particular a pressure chamber 04 formed in the turning bar 01, during the operation. An appropriate feed line for directing compressed air into the hollow space 04 is not specifically represented in the drawings.

[028] The turning bar 01 has micro-openings 03 in its surface area and arranged in the circumferential direction of the turning bar surface on the side which is looped around by the web, in the respective operating situation, as well as in the side of the surface of the turning bar 01 that is not covered by the web 02, i.e. the side facing away from it. Therefore, the turning bar 01 has micro- openings 03 distributed over its full circumference of 360°, on the facing side, as well on the as facing-away side at least on its longitudinal section that is intended for being looped by the web. In a preferred embodiment of the present invention, no device or mechanism is provided for the turning bar 01 which, during the operation of the web-guiding or web-producing machine, would stop the flow of the fluid from the hollow chamber 04 through the micro-openings 03 on the side facing away from

the web 02. This means that in each one of the at least two above-mentioned operating positions, of the turning bar 01 that a fluid can be, or is, flowing out of the micro-openings 03 in a complete circumferential area of 360°. The change of position of the turning bar 01 from one position into the other position requires only pivoting of the turning bar, but no complete covering of the openings, or interruption of the passage between the hollow turning bar interior chamber 04 and the micro-opening 03.

[029] This simple embodiment is more usefully possible because of the provision of the openings 03 as micro-openings 03. A thinner, but more homogeneous air cushion is formed using this micro-opening structure. A required, or a resulting volume flow, and therefore also a flow loss over the "open" side of the guide element, is considerably reduced. In contrast to the provision of openings of large diameter, the large resistance of the micro-openings 03 does not cause the "non-covering" of an area of the openings to result in a sort of short-circuit flow. The partial resistance falling off via the openings 03 has an increased weight in the total resistance.

[030] In a first preferred embodiment of the present invention, the micro-openings 03 are embodied as open pores on the outer surface of a porous, and in particular a micro-porous, air-permeable material 06, such as, for example an open-pored sinter material 06, and in particular, a sinter metal. The pores of the air-permeable porous material 06 have a mean diameter, or mean size of less than 150 μm, for example of 5 to 60 μm, and in particular 10 to 30 μm. The micro-porous, air-permeable material 06 is provided with an irregular amorphous structure.

[031] The choice of the micro-porous, air-permeable material, the dimensions and its charging with pressure have been selected in such a way that 1 to 20 standard cubic meters per m^2 emerge from the air outlet surface of the sinter material 06 per hour, and in particular 2 to 15 standard cubic meters per m^2 emerge from the surface. An air output of 3 to 7 standard cubic meters per m^2 of the surface area of the guide element 01 is particularly advantageous.

[032] The sinter surface is advantageously charged with excess pressure of at least 1 bar, and in particular is charged with air pressure at more than 4 bar, from the hollow space 04. A charge of the sinter surface with excess pressure of 5 to 7

bar is particularly advantageous.

[033] If the hollow space 04 of the turning bar 01 is essentially only made of a body of porous, solid material, so that the turning bar is structured without any further load-bearing layers, at least in its longitudinal area acting together with the web 01, this body, which has been configured to be tube-shaped, for example, is embodied to be self-supporting, with a wall thickness of more than or equal to 2 mm, and in particular with a wall thickness of more than or at least equal to 3 mm. If required, a support can run inside the hollow space 04, on which support the body can be supported at points, or in areas, but which support is not in active connection with the body over its full surface.

[034] To achieve a uniform distribution of the air exiting at the outer surface of the micro-porous material 06, without requiring, at the same time, large layer thicknesses of the micro-porous material 06, with a correspondingly high flow resistance, it is practical, in an advantageous embodiment of the present invention that the turning bar 01 has a solid support 07, which support 07 is air-permeable at least in part and to which the micro-porous material 06 has been applied as a

surface layer 06, as seen in Fig. 2. Such a support 07 can be charged with compressed air, which compressed air flows out of the support 07 through the micro-porous layer 06 and, in this way, forms an air cushion at the outer surface of the turning bar 01. In a particularly advantageous embodiment of the present invention, the porous material 06 is therefore not embodied as a supporting solid body, either with or without a frame structure, but instead as a layer 06 on a, in particular metallic, underlying support material 07, which support material 07 has passages 08 or through-openings 08. A structure is understood to be inclusive of the "non-supporting" micro-porous, air-permeable layer 06, together with the support 07, in contrast to, for example, the "supporting" layers which are known from the prior art. The layer 06 is supported, over its entire layer length and entire layer width, on a multitude of support points of the support 07. For example, the support 07 has, over its width and length which is active together with the layer 06, a plurality of non-connected passages 08. This embodiment is clearly different from an embodiment in which a porous material 06, which is extending over the entire width, and which is active together with the web 02, is configured to be self-

supporting over this distance, and is only supported in the end area on a frame or support, and therefore must have an appropriate thickness.

[035] In the depicted preferred embodiment represented in Fig. 2, the support material substantially absorbs the weight, torsion, bending and/or shearing forces of the component, because of which an appropriate wall thickness, such as, for example, greater than 3 mm, and in particular greater than 5 mm of the support 07 and/or an appropriately reinforced construction have been selected. The support 07 which, for example, borders the hollow chamber 04, and which faces toward the layer 06, or which constitutes the hollow chamber 04 by being appropriately shaped, such as, for example, by being tube-shaped, has, on the side coated with the porous material 06, a plurality of openings 09 for feeding the compressed air, directed from the hollow space 04, through the passages 08, into the porous material 06. Porous material 06 can also be partially contained in the openings 09 of the passages 08 of the support 07 in the area of the walls.

[036] The porous material 06, outside of the passages 08, has a layer thickness which is less than 1 mm. A layer thickness of the porous material 06, of between

0.05 mm and 0.3 mm, is particularly advantageous. A proportion of the open face of the porous material, in the area of the effective outer surface of the porous material, which here is called the degree of opening, lies between 3% and 30%, and preferably lies between 10% and 25%. To achieve a uniform distribution of air, it is furthermore desirable for the thickness of the micro-porous, air-permeable layer 06 to correspond at least to the distance between adjoining openings 09 of the passages 08 provided in the support 07.

[037] The compressed air exiting the sinter material 06 emerges completely, or over substantially 360° of the surface of the material 06, in the circumferential direction in both positions of the turning bars 01.

[038] In accordance with the preferred embodiment of the present invention, which is represented in Fig. 2, a support tube 07 with an arbitrary profile, but preferably with a profile shaped as a circular ring, is arranged as the support 07, or the inner body 07, in the turning bar 01. The wall thickness of the support tube 07 is greater than 3 mm, and in particular is greater than 5 mm. The support tube 07 has a plurality of passages 08 with openings 09 for feeding compressed air into

the porous material 06.

[039] The support 07 which, if desired, is configured as a support tube 07, can itself also be made of a porous material, but with a better or greater air permeability, such as, for example, with a greater pore size, than that of the micro-porous material of the layer 06. In this case, the openings of the support 07 are constituted by open pores in the area of the surface, and the passages 08 are constituted by channels which are incidentally formed in the interior of the support 07 because of the porosity of support 07. The support 07 can also be constituted by any arbitrary flat material which is enclosing the hollow space 04 and which is provided with passages 08, or by shaped material. Combinations of these alternatives can also be considered.

[040] The interior cross section area of a feed line, which is not specifically represented, for supplying compressed air to the turning bar is less than 100 mm^2. It preferably lies between 10 and 60 mm^2.

[041] In a second preferred embodiment of the present invention, as seen in Fig. 3, the micro-openings 03 are provided as openings of penetrating bores 11, and in

particular as openings of penetrating micro-bores 11, which micro-bores 11 extend outward through a wall 12, such as, for example, a chamber wall 12, bordering the hollow chamber 04 which functions as a pressure chamber 04. The bores 11 have, for example, a diameter, at least in the area of the micro-openings 03, of less than or equal to 500 μm, advantageously of less than or equal to 300 μm, and in particular between 60 and 150 μm. The degree of opening of the openings 03, as a portion of the surface area, lies, for example, between 3% to 25%, and in particular lies from 5% to 15%. A hole density is at least 1 / 5 mm^2, and in particular is at least 1 / mm^2 up to 4 / mm^2. Therefore, the wall 12 has a micro-perforation area, at least in an area located opposite the web 02. In an advantageous manner, the micro-perforation area, in a manner that is the same as the passages 08 and layer 06 in the first preferred embodiment, extends over the full circumference of 360°.

[042] A wall thickness of the chamber wall 12 containing the penetrating bores 11, which wall thickness, inter alia, affects the flow resistance of the chamber 04, lies between 0.2 to 0.3 mm, and advantageously lies between 0.2 to 1.5 mm, and

in particular is selected to be between 0.3 to 0.8 mm. A reinforcing structure, which is not specifically represented, such as for example a support extending in the longitudinal direction of the turning bar 01, in particular a metal support, can be arranged in the interior of the turning bar 01, and in particular in the interior of the hollow chamber 04, on which support the chamber wall 12 is supported at least in part or at points.

[043] The wall 12 enclosing the chamber 04 is embodied, for example, as a hollow profiled body, preferably as a tube-shaped hollow profiled body, and in particular as a hollow profiled body with a circular, ring-shaped profile.

[044] An excess pressure in the chamber 04 of maximally 2 bar, and in particular of 0.1 to 1 bar, is of advantage for the embodiment of the micro-openings 03 as openings 03 of bores 11.

[045] The bores 11 can be cylindrical, funnel-shaped or in another special shape, such as, for example, in the form of a Laval nozzle.

[046] The micro-perforations, producing the penetrating bores 11, preferably are formed by drilling by the use of accelerated particles, such as, for example, by a

liquid, such as a water jet, by ions or elementary particles, or by the use of electromagnetic radiation of high energy density, for example light in the form of a laser beam. Producing these micro-bores 11 by the use of an electron beam is particularly advantageous.

[047] The side of the wall 12 having the micro-bores 11 and facing the web 02, may be, for example, a wall 12 made of a special steel, and in a preferred embodiment may be a wall 12 which has a dirt- and/or ink-repelling finish. Wall 12 has a non-represented coating, such as, for example, a coating of nickel or advantageously of chromium, which coating does not cover the openings 10 or the bores 11, and which coating was, for example, been additionally treated, for example, with micro-ribs or has been structured in a lotus flower-effect, or preferably is polished to a high gloss.

[048] In a variation of the present invention, the wall 12 with the bores 11 may be embodied as an insert or as several inserts in a support. The insert, or inserts, can be connected fixedly or exchangeably with the support. The latter mounting is of advantage with respect to cleaning or to an exchange of inserts with different

micro-perforations for use in matching different materials and different web widths. In the embodiment of the present invention, where the openings 03 are arranged substantially over the full surface, such inserts can be arranged on a support extending in the interior of the hollow space 04, for example.

[049] In a further preferred embodiment of the present invention, as seen in Fig. 4, of a pivotable turning bar 01, several chambers 04 are arranged in the turning bar 01. A portion of the surface area of the turning bar 01, such as a sinter area, as represented, or a micro-perforated area, which is not specifically represented, is assigned, in the circumferential direction of the turning bar 01 to each one of the chambers 04. Each chamber 04 can be selectively charged with compressed air, so that in every position of the turning bar 01 the respectively looped area of the turning bar 01 is charged with compressed air. For this embodiment, at least two feed lines 13, which can each be selectively charged with compressed air, for example, are arranged on the turning bar 01. The separate chambers 04 can each be selectively charged via a multi-path valve with compressed air provided by a source, as shown in Fig. 5.

[050] While preferred embodiments of guide elements for a web-producing or web-processing machine, in accordance with the present invention, have been set forth fully and completely hereinabove, it will be apparent to one of skill in the art that various changes in, for example, to width of the web, the source of the compressed air and the like could be made without departing from the true spirit and scope of the present invention which is accordingly to be limited only by the appended claims.

WHAT IS CLAIMED IS: